

# UNIVERSITY OF CALIFORNIA.

## AGRICULTURAL EXPERIMENT STATION.

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### The Extraction of Color and Tannin during Red-Wine Fermentation.

The observations of wine colors made last season in connection with the experimental fermentations at the Viticultural Laboratory, showed unexpectedly great differences in the behavior of the wines from different grapes during the period following fermentation. It was found that some grapes while yielding a very deep color at pressing would lose it rapidly afterward, and frequently fall below others that at pressing had shown materially less color. It was also shown by comparative experiments in fermentation of the same grape under different conditions, that not only the initial intensity of color (*i. e.*, at pressing) varied materially, but also that the rate of loss was different, and that apparent advantages gained (*e. g.*, by hot fermentation) in securing intensity of color do not hold out, and that in certain cases an actual inversion of the proportion at first existing between different samples derived from the same grape may take place. It was further shown that with the deposition of color the tints of wines change from the purplish-reds toward red, and from the reds toward orange-red.

Considering the importance at present attached, commercially, to depth of tint, it was determined to study more closely, this season, the exact course of the development of color in the wines formed under different methods of fermentation, in order to determine the conditions that would secure the greatest depth of tint from the same grape, not only at first but permanently. While the question of permanency

cannot, of course, as yet be decided with respect to the present season's wines, the results already obtained are of sufficient interest to render a preliminary statement desirable. It is not intended to discuss at present other points elicited, that require a longer time for their full demonstration.

As it is usually supposed that the extraction of color and tannin go together and continue to the limits of the ordinary periods of drawing-off, no special arrangement for the control of the progress of tannin extraction was made in the first series of fermentations. But after these had shown conclusively that the above supposition is incorrect, another set of two was carried through with the very last grapes available for the season, *viz.*, a lot of third-crop Zinfandel courteously sent by Mr. John Gallejos. The material for the first series, amounting to some 2500 pounds of excellent Carignane (sugar 25.75, acid .53), was donated for the purpose by Mr. A. Salazar, Jr., of Mission San Jose. The upper part of the table below refers to this last-named lot, the lower to the Zinfandel; (sugar 21, acid .60.)

The conditions established for the several fermentations were as follows:

The bulk (eight) of the first series of fermentations was carried out at the air temperature of 75°, which may be considered as practically the most desirable for most purposes. The charge was 200 pounds for each tank. Four of the tanks were provided with grated frames ("false bottoms") to hold the pomace submerged; one having three of these (Perret's process) so as to divide the pomace into three equal portions; another having the grating placed half way down, so as to hold all

Nov. 22, 1887	Dec. 12, 1887.		Total Decrease Per ct.
	Int.	Tint.	
2.5 1 r.	35.3	1 r.	54.2
2.0 1 r.	20.0	r.	72.6
5.4 1-2 v. r.	45.4	2 v. r.	35.0
0.7 4 v. r.	25.5	4 v. r.	40.0
8.0 1-2 v. r.	31.5	1 v. r.	48.0
2.0 2 v. r.	26.2	2 v. r.	52.4
4.4 1-2 v. r.	35.0	1 v. r.	33.5
3.3 5 v. r.	33.3	4 v. r.	54.4
3.3 4 v. r.	31.3	2 v. r.	45.0
1.3 5 v. r.	23.5	4-5 v. r.	53.0
5.4 2 v. r.	38.0	1-2 v. r.	45.8

of Fermentation, hours.	Dec. 26, '87. Per Cent.	Total Decrease. Per Cent.
.....	34.8 2 v. r.	47.8
S	30.7, 1-2 v. r.	45.0
2	.....	.....



the pomace near the bottom of the tank. The two others had the grating placed near the top of the mash, as is usually done; but in one the wine was pumped over from below and sprayed over the top twice daily, in lieu of any other mode of stirring or aeration; while the other (788) was left to complete its fermentation without any kind of agitation. Of the other four tanks, one (794) was charged with unstemmed grapes, to be gradually crushed by daily stirring ("Morel" process); another (792) was left open and stirred twice daily with a cross-peg stirrer; the third (793) was similarly left open, but was stirred by pumping air to the bottom; while the fourth (787) was treated according to the method adopted for general purposes in the laboratory, viz., a floating, solid cover and twice-daily stirring.

One charge of 230 pounds (796) was fermented according to the same method, with an air temperature of 62°. In this, as well as in the eight preceding, the mash was set at 63°.

Two charges of 230 pounds each were fermented with the air temperature kept at about 90°; the mash was set at 86°. One of these tanks (795) was provided with floating cover as above; the other (797) was left uncovered and both received twice-daily stirring.

The observations given in the table are those made at 9 A. M. In the second series, two tanks only were used, both with floating top and stirring, as above; but one (799) with an air-temperature of 75° and set at 63°, the other (800) set at 86° and kept in a warm chamber with air at about 90°; the charges in this case were 60 pounds each; the observations were made at short intervals in order to be sure of not missing the maxima of color.—The latter are printed in full-face type, for a readier view of the facts.

The figures given in the columns headed "Intensity" refer to the scale in which a disc of wine four-tenths millimeter or about the sixty-second part of an inch in thickness is equal in intensity to the type discs of Chevreul's color scale.

In the columns headed "Tint," r. means red and v. r. violet-red, the figures referring to the numbered tints of Chevreul's scale.

The last column to the right shows the percentage of decrease, referred to the deepest tint observed, taken as 100.

A glance at the full-face figures shows at once the very great differences in the greatest intensity of color attained in these experiments, under the varying conditions. The maximum, 77.0, was reached on the third day by No. 795, one of the two hot fermentations, being the one that reached the maximum temperature of 106°. The minimum, 42.5, is shown by tank No. 788, fermented according to one of the most usual methods of procedure, viz.: A single grated frame keeping the pomace submerged just below the surface. That is,

No. 788 attained only 55.5 per cent of the color reached by No. 795 three days before. But when, as in the case of No. 789, the pomace was held down near to the bottom of the tank, a maximum of 60.0 of the color scale was reached within the same time. Where the single frame was used near the surface, but the wine pumped over from beneath (No. 790), 55.0 was reached, and that two days earlier; where the three frames were used (No. 791) 57.1 was the color, the maximum being reached at the same time as in the two former, viz.: on the sixth day.

Comparing the three tanks treated in the same manner, but at different temperatures, to wit, Nos. 796, 787 and 795, having a floating cover and stirring twice daily, it appears that the same maximum of 70.0 was reached within the same time (fifth day) both with air-temperatures of 62° and 75°; in the one kept in a chamber at 90°, the maximum of 77.0 was attained on the morning of the third day. This marked influence of high temperature upon the *extraction* of color is also shown in the second series of the table, as well as in last year's.

Contrary to expectation, the "Morel process," in which the frequent stirring and prolonged fermentation would lead one to expect a deep color, comes next to the lowest, with only 50.0 of color, reached on the sixth day.

It thus appears that in all but one of these cases (795) the maximum of color was attained between the fourth and sixth days. After reaching the maximum, whether the wine is drawn or not, there immediately begins a decrease, which, on the whole, is the more rapid the higher the intensity that has been reached. But the *percentage* of decrease (see last column of table) varies materially, according to the method of fermentation employed, as will be seen from the figures in the last column to the right. But what interests us most is the absolute intensity *remaining after the same lapse of time*; and in that respect the color readings last made (Dec. 12th) are very instructive, as they doubtless foreshadow the ultimate outcome more or less accurately. It will be seen that the deepest tint (45.0) was at that time retained by the wine made according to the mode (with floating cover and twice-daily foulage) adopted in the viticultural laboratory, and at 75° air temperature (No. 787). Next highest (38.0) are Nos. 796 and 791, the first also fermented with floating cover but at 62°, the second, according to Perret's method, with three frames. No. 795, fermented with floating cover but at 90°, and at first showing the deepest tint of all, comes next below (35.3) having lost 54.2 per cent of its color. Nos. 792 and 793, both greatly exposed to air during fermentation, stand respectively 12 and 14 points below No. 787, fermented with cover on; and the same influence of excess of air in diminishing colors is even more strikingly shown on comparing Nos. 795 and



797, both fermented at the high temperature but one with cover on, the other open; the color ratio being 35.3 to 20.0.

Omitting for the present the discussion of the causes of these differences, the broad fact remains that in all cases the maximum of color was reached, and its diminution began, long before the fermentation was completed; that therefore the increase of alcohol beyond a certain point which from actual measurement in one case was only five per cent, has no influence in promoting extraction of color. Also, that the long-continued maceration sometimes practiced with the idea that it increases the color, is erroneous.

In the second series of the table, as in the first, the hot fermentation completed the extraction of color (12 hours) sooner than the cooler one; and it is interesting to note the rapid course of these fermentations, as compared with the long-drawn-out process in the Carignane series, due, of course, to the difference in the sugar and acid contents. The high temperature in this case rushed the fermentation right through, but the maximum reached was only 98.5° against 106° in the former case. Here also the color was at first much deeper in

the hot than in the cold fermentation (66.6 against 55.8), but the decrease was also more rapid, as is shown in the later observations.

But during the whole time there was a steady increase in the tannin contents, ending with .20 per cent for the hot and .144 for the cooler fermentation. As it is proved that in sound wine there is no subsequent diminution of tannin, this shows that longer time on the pomace steadily increases the tannin, as has been supposed; also, that hot fermentation materially favors the extraction of tannin.

The practical precepts following from these experiments may then be thus stated:

1. Maceration of the wine on the pomace after fermentation is through, increases tannin, but adds nothing to color.

2. When blends are to be made for the sake of color, or when blends of white and red wines are to be made, it should, whenever possible, be done *before* fermentation, in order that the white juice may help to hold up the color that otherwise will come down very rapidly during the first weeks after drawing-off.

Berkeley, Dec. 30, 1887. E. W. HILGARD.

